ERIC Document Resume	See Instruction Sheet	DATE OF RESUME 8/12/65	DATE RECEIVED

A. PUBLICATION DATA

1. ERIC NUMBER	2. ORIGINATOR CONTROL NO(S).	3. IDENTIFICATION NO.
ED000473	7224	N.A.

DO NOT WRITE IN SPACE BELOW

4. AUTHOR(S): LeBold, W. K.

5. TITLE OF DOCUMENT ABSTRACTED: Class Size in Engineering Science - An Experimental Approach

6. PUBLICATION TITLE: N.A.

7. EDITOR(S): N.A.

8. PLACE OF ORIGIN
ORG. Purdue University
ST.
CITY, STATE Lafayette, Indiana
TELE. EXT.
INST/LOC CODE

9. PUBLISHER OR SOURCE: Purdue University

10. VOL.	11. PAGES	12. MO./YR.	13. TOTAL PP.
N.A.	N.A.	58	11

MICROFILM COPY AVAILABLE YES ☒ NO ☐

COPYRIGHT GRANTED YES ☐ NO ☒

COPYRIGHT RELEASE FILED YES ☐ NO ☐

TYPE OF REPORT
PROPOSAL ☐
IN-PROGRESS ☐
FINAL ☒
FOLLOW-UP ☐

OTHER ERIC REFERENCES:

ERIC SATELLITE CODE

B. INDEXING DATA

14. SUBJECT AREA

15. TYPE OF ENDEAVOR Experimental Study

16. INDEXING TERMS (6-12)

	evaluation	attitudes		
class size	effectiveness	teaching methods		
science	students	experimental studies		
		engineering education		

17. ABSTRACT (MAX. 250 WORDS)

Describes an experiment in which students in two sophomore-junior courses in engineering science were assigned to large (75 students) and small (25 students) classes and each instructor was assigned a large and small class. Data and interpretations are given on final examination results, instructor ratings, course ratings, student attitudes and behavior, and evaluations of the experiment by the instructors.

ERIC No.

18. SOURCE OF ABSTRACT

C. FUNDING DATA

19. SUPPORTING ORGANIZATION	20. DIVISION OR DEPT.	21. CONTRACT NO. / PROJECT NO.
	22. TOTAL COST OF PROJECT	
	23. DURATION OF PROJECT	U.S. Department of Health, Education, and Welfare Office of Education

IV - 18 (engineering)

IV-18

7224

Class Size in Engineering Science --an experimental approach*

W. K. LeBold
Purdue University

One of the traditional higher education issues that has been debated, studied and restudied is the one dealing with "class size." Predicted unprecedented enrollments have given new life to administrative directives, faculty symposia, and student bull-sessions. One of the more recent exchanges of opinion on this topic has been precipitated by Dr. A. C. Eurich's pronouncements:

> For reasons not readily apparent educators have made a fetish of small classes. The smaller the class, they assume, the better the instruction. The ideal is expressed by the cliche: "Mark Hopkins on one end of the log, and the student on the other." In stating this position educators seldom ask about the qualifications of a Mark Hopkins or of the student....In classroom teaching, the one-to-one relationship means more than the mere physical presence of two people in the room.
>
> The ratio also needs to be considered in relation to the objectives of instruction. The issue is no longer one of class size. In fact, the concept of class size is archaic. The issue instead is one of how the whole range of possibilities can be used to bring the best instruction to the student; independent study, individual instruction and counsel, laboratory work and practice, small class discussions, large class demonstrations and lectures, television with the ablest professors reaching thousands of students, and motion pictures which will bring the greatest teachers to successive generations of students. (1)

U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
Office of Education

This document has been reproduced exactly as received from the person or organization originating it. Points of view or opinions stated do not necessarily represent official Office of Education position or policy.

To which Professor E. C. Kirkland, in a recent Dartmouth honors convocation, replied:

> Doctor A. C. Eurich, vice-president of the Fund for the Advancement of Education, a quaintly named organization whence the good dollars if not the good ideas come, recently urged "that educators think in modern, twentieth century terms. He outlined a plan to bring America's greatest teachers into college classrooms through television, kinescope, and film."
>
> He also challenged the educational theory that the pupil-teacher ratio should be kept low. "Where does the notion that twenty-five students are enough for a teacher come from? This is an old, shop-

* Paper presented at the Southeastern Section Meeting of the American Society for Engineering Education, April, 1958.

ED000473

worn belief, handed down to us from an early era before the day of telegraphy, photography, motion pictures, microphones, radio, tape recorders and television. A good teacher need not be limited to twenty-five, fifty or any set number of students." If the inquiring Doctor is really ignorant as to where the idea of smaller classes comes from, I can tell him. It comes from experience. It comes from the realization that education is not a one-way street from teacher to student but is a reciprocal relationship between the two. Not that the student ordinarily educated the teacher--far from it--but that the student with the aid of the teacher educates himself. Dr. Eurich's ideas on this score are so divergent from American experience and purpose they deserve the epithet "un-American," in the genuine sense of the word.

I share Dr. Eurich's aversion for the class of twenty-five not because it is too small but because it is too large to "learn American." Let us lay aside wiggle and wobble and recognize that the nearer instruction approaches an individual relationship the better the quality of education generated. If we must keep the proof within the framework of historical quotation, we can resort to President Garfield's famous preference "for a student at one end of the log and Mark Hopkins at the other."(2)

This exchange of ideas, profound as it is, is not atypical of many of our colleagues in engineering education.

The previous research in this area can perhaps be best summarized by the following conclusions from the Encyclopedia of Educational Research:

> Interpretation of class-size research. The results of investigations on practically every phase of class size reveal wide disagreements in the findings. This is true partly because of variance in the experimental set-up but mainly because of failure on the part of the experimenter to recognize adequately or to control powerful factors other than class size which have an important influence on the results. Hence it is evident that few of the problems attacked have been conclusively solved. However, certain conclusions appear to be justified:
>
> 1. There is great variation in actual class sizes both within and between subjects, schools, school systems, and school levels. While some of this variance seems unavoidable, much is unnecessary and probably undesirable.
> 2. Under typical teaching procedures mere size of class has little significant influence on educational efficiency as judged by measurable pupil outcomes.

3. The weight of experimental evidence places the burden of proof squarely upon the proponents of small classes.
4. There is urgent need for scientific establishment of optimum class sizes in terms of the fundamental objectives of education. This may necessitate the establishment of several standards to fit varied conditions.
5. Future class-size research should be carefully planned to insure rigid experimental control, a limited field of attack, and specific rather than general objectives. (3)

We became interested in this problem of class-size at Purdue recently. We found that few, if any, controlled studies in engineering had been conducted. Our engineering science staff at Purdue expressed an interest in such a study. They offer a few basic "mechanics" courses that are common to all engineering fields. These courses were ideal for our experimental study.

Students in two sophomore-junior courses in Engineering Science were assigned to large (75 students) and small (25 students) classes. Each instructor was assigned a large and small class.

The experimental design was as follows:

Table I -- Basic Design

Engineering Science 204

	Small	Large
9 am	Instructor 2	Instructor 1
2 pm	Instructor 1	Instructor 2

Engineering Science 312

9 am	Instructor 5	Instructor 3
1 pm	Instructor 4	Instructor 5
3 pm	Instructor 3	Instructor 4

The criteria used are given in Table II.

Table II - Criteria

(1) Comprehensive Examinations in the respective courses.
(2) Ratings on the Purdue Rating Scale for Instruction.
(3) Engineering Science Student Survey.
(4) Instructor's Reports on the Class Size Experiment.

Final Exam Results: The results of the final examinations are given in Table III.

Although all students officially registered in the course did not take the group final examination, a substantial number did:

145 out of 173 in E. S. 204 --- (85%)
248 out of 261 in E. S. 312 --- (95%)

Table III -- Mean Scores on Final Examinations

Course	Maximum Score	Mean Score Small	Mean Score Large	Difference	Statistic "t"	Significance
204	44	23.11	25.16	-2.05	2.17	@ .05 level
312	55	42.59	41.24	1.35	1.70	Not significant

The results of the final examination indicate a statistically significant difference between large and small classes in Engineering Science 204 in favor of the large class and no significant difference for Engineering Science 312.

Instruction Rating Scales:

The student rating sheets were administered during the last week of class and filled out anonymously (except for one small class which was sent the rating scale and questionnaire in the mail). Table IV summarizes the results.

The first ten items in Table IV - A represent ratings of the instructor. The maximum rating was 10 and the minimum rating was 1.

The last 16 items (Table IV - B) indicate an evaluation of factors over which the instructor often has little control. Ratings are based on a 5 point scale varying from 5 (excellent) to 1 (extremely poor).

Table IV -- Purdue Rating Scale for Instruction for Small and Large Classes

Table IV - A. Instructor Ratings

(10 point scale - 10 highest - 1 lowest)

Course Number	Mean Small	Mean Large	Difference	Significance
1. Interest in Subject:				
204	8.75	8.64	.11	Not Significant
312	7.97	8.03	-.06	Not Significant
2. Sympathetic Attitude toward Students:				
204	7.76	7.43	.33	Not Significant
312	7.66	6.92	.74	(.05)
3. Fairness in Grading:				
204	8.13	8.42	-.29	Not Significant
312	8.50	8.17	.33	Not Significant
4. Liberal and Progressive Attitude:				
204	8.45	7.93	.52	Not Significant
312	8.45	8.08	.37	Not Significant
5. Presentation of Subject Matter:				
204	7.28	7.15	.13	Not Significant
312	7.45	7.49	-.04	Not Significant
6. Sense of Proportion and Humor:				
204	7.86	8.15	-.29	Not Significant
312	8.01	7.68	.33	Not Significant
7. Self-reliance and Confidence:				
204	7.94	8.75	-.81	(.01)
312	8.64	8.75	-.11	Not Significant
8. Personal Peculiarities:				
204	7.42	8.23	-.81	(.05)
312	8.02	7.62	.40	Not Significant
9. Personal Appearance:				
204	8.27	8.64	-.37	Not Significant
312	9.14	8.95	.19	Not Significant
10. Stimulating Intellectual Curiosity:				
204	6.89	7.07	-.18	Not Significant
312	7.54	7.01	.53	(.05)

Table IV - B. Course Ratings

(5 point scale - 5 excellent, 3 average, 1 extremely poor)

Course Number	Mean Small	Mean Large	Difference	Significance
11. Suitability of the method or methods by which subject matter of the course is presented (recitation, lecture, laboratory, etc.):				
204	3.45	3.15	.30	Not Significant
312	3.77	3.26	.51	Not Significant
12. Suitability of the size of the class (consider the subject matter and type of class - lecture, lab., etc.):				
204	4.42	2.33	2.09	(.001)
312	4.57	2.00	2.57	(.001)
13. The degree to which the objectives of the course were clarified and discussed:				
204	4.18	3.30	.88	(.001)
312	3.76	3.35	.41	(.001)
14. The agreement between the announced objectives of the course and what was actually taught:				
204	3.54	3.62	-.08	Not Significant
312	3.89	3.57	.32	(.05)
15. Suitability of the reference materials available for the course:				
204	3.00	2.75	.25	Not Significant
312	3.60	3.37	.23	Not Significant
16. Suitability of the laboratory facilities available for the course:				
204	2.16	2.50	-.34	Not Significant
312	2.63	2.65	-.02	Not Significant
17. Suitability of the assigned textbook:				
204	2.87	2.76	.10	Not Significant
312	3.78	3.60	.18	Not Significant
18. The use made of tests as aids to learning:				
204	2.66	2.75	-.08	Not Significant
312	3.33	2.93	.40	(.05)
19. Amount of freedom allowed students in the selection of the materials to be studied (considering the subject matter):				
204	2.30	2.40	-.10	Not Significant
312	2.76	2.41	.35	(.05)
20. How the course is fulfilling your needs (consider your ultimate as well as your immediate goals):				
204	2.97	3.01	-.04	Not Significant
312	3.86	3.29	.57	(.001)

Table IV - B. Continued

Course Number	Mean Small	Mean Large	Difference	Significance
21. Range of ability in the class (are there too many extremely dull or extremely bright students?):				
204	3.27	3.20	.07	Not Significant
312	3.39	3.24	.15	Not Significant
22. Suitability of the amount and type of assigned outside work:				
204	3.46	3.28	.18	Not Significant
312	3.49	3.21	.28	(.05)
23. The weight given to test in determining the final grade for the course:				
204	3.38	3.40	-.02	Not Significant
312	3.56	3.32	.24	Not Significant
24. Coordination of the tests with the major objectives of the course:				
204	3.38	3.41	-.03	Not Significant
312	3.76	3.37	.39	(.01)
25. Frequency of tests:				
204	3.67	3.62	.05	Not Significant
312	3.90	3.82	.08	Not Significant
26. The overall rating of the instructor:				
204	3.83	3.73	.10	Not Significant
312	4.15	3.81	.34	(.05)

The individual profiles (not shown) indicated that some instructors were rated quite differently by their large and small classes. One instructor, for example, was rated more favorably by his small class on instructor characteristics, while two other instructors were rated more favorably by their large class. Other instructors were given similar ratings by their small and large classes.

Engineering Science Student Survey:

A special questionnaire was designed to get at specific points of interest in this study which were not included in the Purdue Rating Scale for Instruction. The student

Survey questionnaire attempted to determine behavior patterns and student attitudes regarding class size. The results are summarized in Table V.

Questions No. 1-7 (5A-F) on the questionnaire deal with reported behavior rather than student attitudes which are covered by Questions 8-13 and 19-31. The latter deal with student attitudes or opinions regarding the course and class size. Questions 14-18 deal with the student's previous experience with class sizes ranging from less than 15 students to over 100 students.

The small and large classes indicated about the same amount of outside study time. In the large classes, about 17% of the students reported that they did not ask any questions in class during the semester, as to 2% in the small classes. The small class gave more favorable ratings to the courses than the large classes on the amount of class discussion, individual attention, opportunity to ask questions, general organization and their overall evaluation.

Students indicated that classes between 20-40 in math, physical science, and engineering would be ideal. In the non-technical area, they felt larger courses would be ideal; 15-20% favoring classes of over 50 students. In the courses under study 80% of the students favored class sizes of 20-40.

When different possibilities were presented to the students they indicated preferences in the following order:

Medium size section (25 students) and average teacher
Large section (75 students) and above average teacher
Alternate large lectures and small classes
Small sections and below average teacher
Very large section (150-up) and outstanding teacher
Alternate TV and average class sessions
Television lecture course and outstanding teacher

Table V -- Summary of the Engineering Science Student Survey for Large and Small Classes in Engineering Science 204 and 312

	E. S. 204		E. S. 312	
	Small	Large	Small	Large
	Median Number of Hours:			
1. How many hours per week on the average do you study for this course?	6	6	7	6
	Median Number of Occasions:			
2. Number of occasions you consulted your instructor outside of class regarding this course?	1	0	1	1
3. Number of occasions you consulted some other staff member regarding this course?	0	0	0	0
4. Number of occasions you asked questions in class regarding the course?	16	4	13	4
5. Number of occasions you studied for this course with other students in your section?	0	1	0	1
6. Number of occasions you studied for this course with other students taking the course, but not in your section?	2	0	0	2
7. Number of occasions you consulted regarding this course students not now taking the course?	0	0	0	0
	Median Rating*			
8. Compare this course with other courses as to amount of class discussion?	4	3	3	3
9. Compare this course with other courses as to amount of individual attention given?	4	2	3	2
10. Compare this course with other courses as to opportunity to ask questions in class?	4	3	4	3
11. Compare this course with other courses as to physical atmosphere - facilities?	3	3	3	3
12. Compare this course with other courses as to general organization of the course?	4	3	3	3
13. Compare this course with other courses as to interest value of the course?	3	3	4	4
14. Compare this course with other courses as to its overall evaluation.	4	3	4	3

* 1 - Extremely poor; 2 - Below Average; 3 - Average; 4 - Above Average; 5 - Excellent

	E. S. 204		E. S. 312	
	Small	Large	Small	Large
	Median Number of Courses			
Estimate the number of college courses to date having the following:				
15. Less than 15 students	0	0	1	1
16. 15-49 students	21	16	21	22
17. 50-99 students	2	2	2	2
18. 100-up students	2	1	2	2
	Median Number of Students			
19. How many students would be ideal for a Mathematics course?	25	25	24	24
20. How many students do you feel would be ideal for Physics and Chemistry?	32	29	26	26
21. How many students do you feel would be ideal for Engineering in your field?	25	25	22	23
22. How many students do you feel would be ideal for Engineering outside your field?	27	27	25	26
23. How many students do you feel would be ideal for a Non-technical course?	37	37	35	36
24. How many students do you feel would be ideal for this course?	25	26	24	28
	Median Rank*			
Indicate your order of preference for each of the following:				
25. Very large section (150 students up) and outstanding teacher	4	3	4	3
26. Large section (75 students) and above average teacher	3	3	3	3
27. Medium size section (25students) and average teacher	1	1	1	1
28. Small section (10 or less) and below average teacher	5	5	6	5
29. Alternate large lectures and small class sessions	3	4	3	3
30. Television lecture course (outstanding teacher)	6	6	6	7
31. Alternate TV sessions (outstanding teacher) and average class session(average instructor)	5	5	5	6
	Median Index			
32. What was your cumulative index at the beginning of the semester?	4.4	4.5	4.6	4.5

* 1 - most desirable; 2 - next; 7 - least desirable

Instructor's Evaluation of Class Size Experiment:

Although the instructors differed in their evaluations and preferences for small and large classes, there was a general concensus that:

(1) the use of large classes demand auxiliary personnel such as graders if any substantial saving in instructor timeis to be realized.

(2) the large classes could have been larger.

(3) the main disadvantage of large classes is the lack of personal attention.

Acknowledgement:

The author has used material prepared in cooperation with the Division of Educational Reference and the Division of Engineering Science as part of Research Project #19-57. In particular, the assistance of C. S. Cutshall, C. W. deCeault, J. F. Jones, W. M. Lear, J. A. Norton, V. R. Parfitt, G. R. Spalding, and E. A. Trabant, is acknowledged.

References

1. Eurich, A. C. "Better Instruction with Fewer Teachers," Journal of Higher Education, May 1956, XXVI, pp 239-244.

2. Kirkland, E. C. "Learn American," Colleges and Universities 1957, XXXII, pp. 319-323.

3. Monroe, W. S. Editor "Class Size," Encyclopedia of Educational Research, The Macmillen Co., 1941, pp 199-200.

4. Cutshall, C. S. and Others "A Class Size Study in Engineering Science" Research Project #19-57. Division of Educational Reference, Purdue University, 1957.